Gertsch

INSTRUCTION BOOK
FOR
RS SERIES
RESOLVER STANDARDS

ELECTRONIC INSTRUMENTS

INSTRUCTION BOOK

FOR

RS SERIES

RESOLVER STANDARDS

GERTSCH PRODUCTS, INC.,
LOS ANGELES 16, CALIFORNIA

March 13, 1962

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WARRANTY POLICY

Gertsch Products, Inc. guarantees any equipment which we manufacture to meet the advertised performance specifications applying to that particular equipment.

Gertsch Products, Inc. warrants each instrument of its manufacture to be free from defects in material and workmanship. Our obligation under this Warranty is limited to servicing or adjusting any instrument returned to our factory for that purpose, and to making good at our factory any part or parts thereof except tubes, transistors, diodes, fuses, batteries or RatioTran potentiometers which shall, within one year after making delivery to the original purchaser, be returned to us with transportation charges prepaid, and which on our examination shall disclose to our satisfaction to have been thus defective.

Gertsch Products, Inc. reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This Warranty is expressly in lieu of all other obligations or liabilities on the part of Gertsch Products, Inc., and Gertsch Products, Inc. neither assumes nor authorizes any other person to assume for them any other liability in connection with the sales of Gertsch Products, Inc. instruments.

This Warranty applies only to the original purchaser unless approval for resale is obtained in writing from Gertsch Products, Inc.

Equipment----------

Serial No. ----------

Sold to ----------

Date Sold ----------

GERTSCH PRODUCTS, INC.
3211 South LaCienega Boulevard
Los Angeles 16, California

WARRANTY POLICY

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SECTION I

GENERAL DESCRIPTION

Gertsch Resolver Standards are precision transformer instruments, designed to simulate the "ideal" electrical outputs (± 2 seconds-of-arc) of a Resolver Control Transmitter (RX). When driven by an external signal source the Resolver Standard generates, in precise angular increments (normally 5°), two isolated voltages directly proportional to the sine and cosine of the angle displayed on the dial. Quadrant switching is provided to simulate operation over a full 360°.

Because of their very low output impedance and extremely low output impedance unbalance, Resolver Standards may be operated under normal load, with very little degradation of accuracy.

Resolver Standards are generally used to transmit precise angular data to Resolver Differential Transmitters (RD's) and Resolver Control Transformers (RC's). Most commercially available resolvers of this type may be excited from a Resolver Standard without appreciably affecting the 2 second accuracy.

SECTION I

GENERAL DESCRIPTION

1) Model Number and Type			Rotor Input Voltage Ein and Nominal Frequency	Max Stator Output Voltage E_s (max)	Maximum Effective Output Impedance Unbalance at Nominal Frequency
2 Knob	1 Knob	Rotary Solenoid			
RS-1R	RS-4R	RS-7R	26V-400cps	11.8V	(.01+j.001)ohms/SIN 2 θ
RS-2R	RS-5R	RS-8R	115V-400cps	90V	(.05+j.005)ohms/SIN 2 θ
RS-2AR	RS-5AR	RS-8AR	115V-400cps	11.8/90/115V	(.05+j.005)ohms/SIN 2 θ
RS-2BR	RS-5BR	RS-8BR	115V-400cps	115V	(.05+j.005)ohms/SIN 2 θ

2) Frequency Range: *400 - 1600 cps

3) Angular Accuracy (no load): ±2 seconds-of-arc

4) Transformation Ratio, $N = \frac{E_s \text{ (Max)}}{E_{in}}$: ±.1% maximum

5) Effective Variation in Transformation Ratio (Δ N) From Nominal, As a Function of Angular Position: ± 1% maximum

6) Angular Range: 0 - 360°, continuous

7) Angular Increments: 5°

8) Size (Rack Mounted): 19-1/2" x 3-1/2" x 10-1/4" D (Stepper Switch Models, 14-1/2" D)

NBS TRACEABILITY

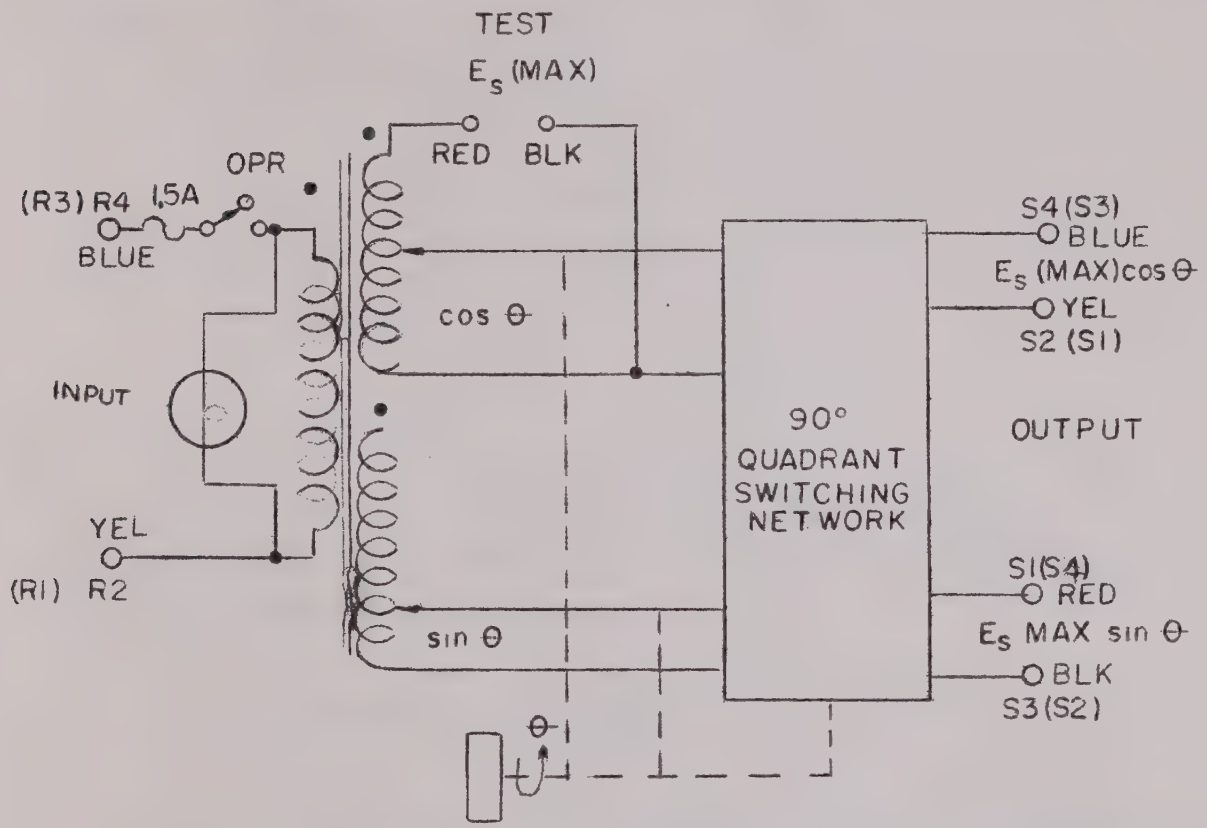
A certificate is available, on request, showing accuracy measured in terms of a standard which has been certified by the National Bureau of Standards in Washington, D. C. (NBS Calibration Test 1. 3/160058)

*Units may be operated at frequencies lower than the above, by reducing the input voltage in direct proportion.

SECTION II

CIRCUIT DESCRIPTION

The following figure illustrates the basic circuitry common to all Gertsch Resolver Standards:



Operational versatility of the Resolver Standard is increased by the use of two sets of terminal identifications. The input identification (R2-R4 or R1-R3) selected, determines the output identification markings to be used by the operator. The binding posts are color coded per Mil-R-21530D, for the terminal identifications not parenthetically enclosed (R2-R4 excitation).

The phase relationships of the output voltages relative to the input voltage, conform to Mil-R-21530D for both sets of terminal identifications. That is:

$$E_{S1-S3} = N(E_{R1-R3} \cos \theta - E_{R2-R4} \sin \theta)$$

$$E_{S2-S4} = N(E_{R2-R4} \cos \theta + E_{R1-R3} \sin \theta)$$

Where N is the transformation ratio of the Resolver Standard, and θ is positive for CCW rotation from electrical zero (EZ), when viewed from the shaft end.

The equivalent angular position of a Resolver Standard is uniquely and completely defined as a function of the ratio of the output voltages to each other:*

$$E_{S3-S1} = NE_{R2-R4} \sin \theta$$

$$E_{S2-S4} = NE_{R2-R4} \cos \theta$$

Therefore, ideally:

$$A = \tan \theta,$$

where $A = \frac{E_{S3-S1}}{E_{S2-S4}}$

The relationship between a deviation in ratio and an equivalent angular error is derived by differentiating the above equation with respect to θ and converting to PPM and seconds-of-arc.

$$\Delta \theta \text{ (seconds)} = \frac{\Delta A \text{ (PPM)}}{4.85 \sec^2 \theta}$$

The maximum effect of loading on the accuracy of a Resolver Standard may be calculated from the following approximation:

$$\Delta \theta \text{ (seconds)} \cong \pm \left[\text{Real Part of } \left| \frac{Zo \text{ (unbalance)}}{Z_{so}} \right| \times 10^5 - 2 \right],$$

where Z_{so} is the stator impedance of the load, with the rotor open, at 0.707 E_s (max).

The Z_o (unbalance) of a Resolver Standard may be approximated at frequencies other than 400 cps, by assuming the j component to be directly proportional to frequency.

The maximum line current from the primary and secondary of a

*For this reason, the deviation in transformation ratio from the nominal as a function of angle, does not affect the angular accuracy.

-olver Standard may be calculated from the following approximations:

$$I_p \text{ (max)} \tilde{=} \frac{1.4NE_s \text{ (max)}}{Z_{so}} \quad \text{at } 45°,\ 135°,\ 225° \text{ and } 315°$$

$$I_s \text{ (max)} \tilde{=} \frac{E_s \text{ (max)}}{Z_{so}} \quad \text{at } 0°,\ 90°,\ 180° \text{ and } 270°$$

SECTION III

OPERATION

Maximum accuracy may be obtained from Resolver Standards by observing the following precautions:

1) Never fuse the outputs.

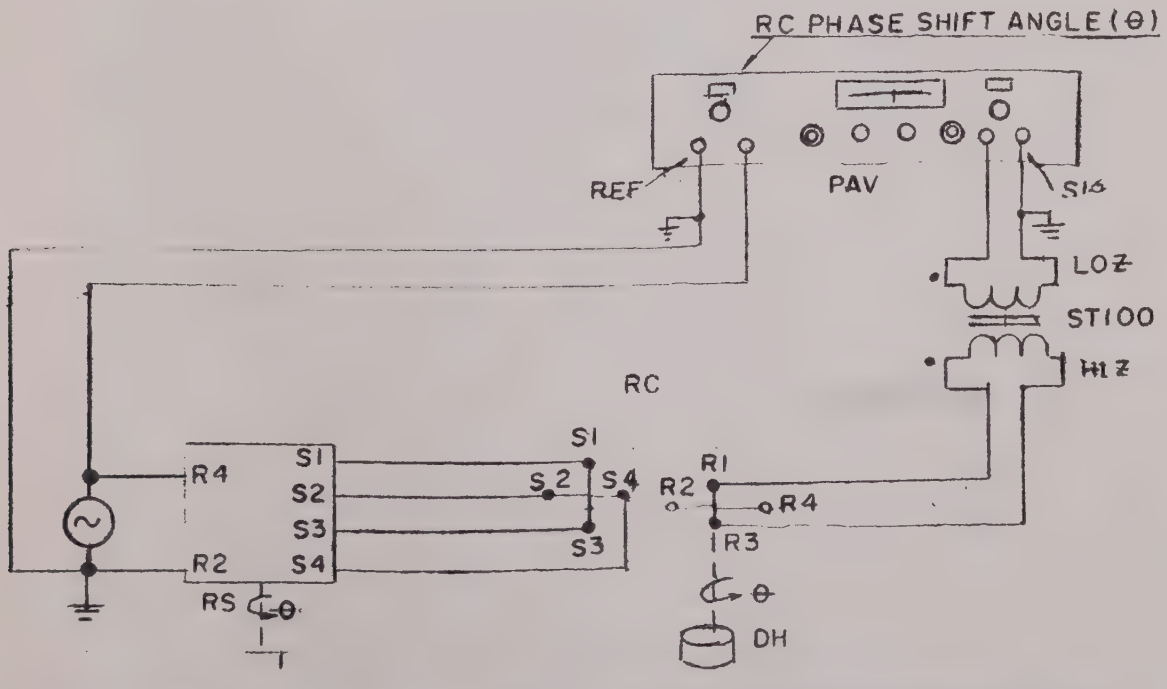
2) Do not purposely apply an unbalanced load.

3) Always use high quality switches, with very low contact resistance, whenever it is necessary to switch the outputs of a Resolver Standard.

4) Use No. 18 tinned copper wire from the output of the Resolver Standard to the load, and attempt to keep the total lead length from each output terminal approximately the same.

5) Stator current should be limited to approximately one ampere for normal switch contact life and should never exceed two amperes.

A typical set-up might be as follows:



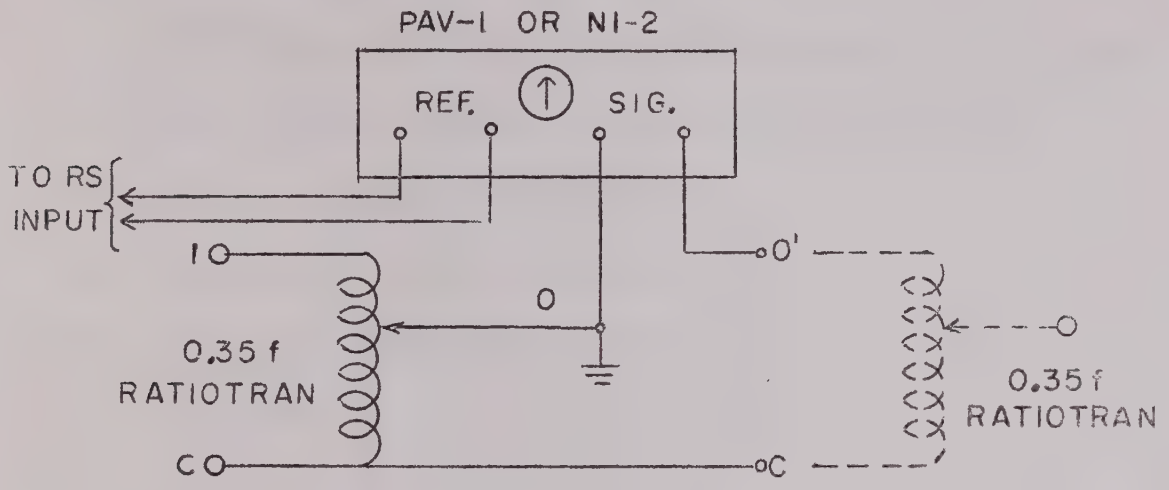
RC Angular Accuracy Test Note, that either the "proportional voltage nulling" or the "proportional voltage gradient" technique may be used.

nulling" or the "proportional voltage gradient" technique may be used.

SECTION IV

CALIBRATION AND MAINTENANCE

The angular accuracy of a Resolver Standard may be determined by using the following test set-up and tables:



NOTE: For maximum accuracy, a second RatioTran should be used to more closely simulate a balanced load. The effect of this will be maximum at 45°, 135°, 225° and 315°.

θ	S1	S2	S3	S4
0 - 40	O'	C	C	I
45 - 85	I	C	C	O'
90 - 130	I	O'	C	C
135 - 175	O'	I	C	C
180 - 220	C	I	O'	C
225 - 265	C	O'	I	C
270 - 310	C	C	I	O'
315 - 355	C	C	O'	I

The theoretical ratios, and 2 second tolerances are given below:

θ								$A_{theoretical}$	ΔA (ppm)
0		90		180		270		0.000000	9
5	85	95	175	185	265	275	355	0.087489	9
10	80	100	170	190	260	280	350	0.176327	10
15	75	105	165	195	255	285	345	0.267949	10
20	70	110	160	200	250	290	340	0.363970	11
25	65	115	155	205	245	295	335	0.466308	11
30	60	120	150	210	240	300	330	0.577350	13
35	55	125	145	215	235	305	325	0.700208	14
40	50	130	140	220	230	310	320	0.839100	16
	45		135		225		315	1.000000	19

The effective output impedance unbalance of the Resolve Standard may be readily checked by applying a BALANCED load to the output and measuring A. When testing with an inductive load, it is recommended that non-ferromagnetic inductors (GR type 1482 or equivalent) be used to prevent output voltage variations from changing the inductance of the load.

It isnecessary to connect the RatioTran directly to the output terminals of the Resolver Standard to eliminate errors resulting from voltage drops in interconnecting leads to the load.

The Resolver Standard incorporates the basic design and accuracy characteristics of the standard Gertsch RatioTran and should therefore provide years of maintenance-free service. It is recommended however, that the switch contacts be serviced every three to six months, thus preventing build-up of contact resistance.

In the event that major servicing or re-calibration is required, contact your local Gertsch representative or the factory.

PRELIMINARY INSTRUCTIONS
FOR
ROTARY - SOLENOID UNITS

1. The Remote/Local toggle switch on the front panel selects either "Local" or "Remote" control of the "Advance 5°" function. Note, in order for the "Advance 5°" function to operate properly it is necessary for the "Reset to 0°" function to be wired up correctly (per step 3, 4, or 5)!

2. For remote control of the "Advance 5°" function, place the toggle switch in the "Remote" position and short "A" and "B" pins on the rear connector once for each 5° step desired.

3. For local control of the "Reset to 0°" function, the rear panel male connector supplied with the unit (with two internal jumpers - D to E and J to H) must be in place.

4. For remote control only of the "Reset to 0°" function, remove the two jumpers inside the rear panel male connector and make the following connections to an external two pole-two position push button:

Switch #1:	Pole --- Pin C
	N. C. --- Pin E
Switch #2:	Pole --- Pin F
	N. O. --- Pin J

5. For both remote and local control of the "Reset to 0°" function, make the following connections:

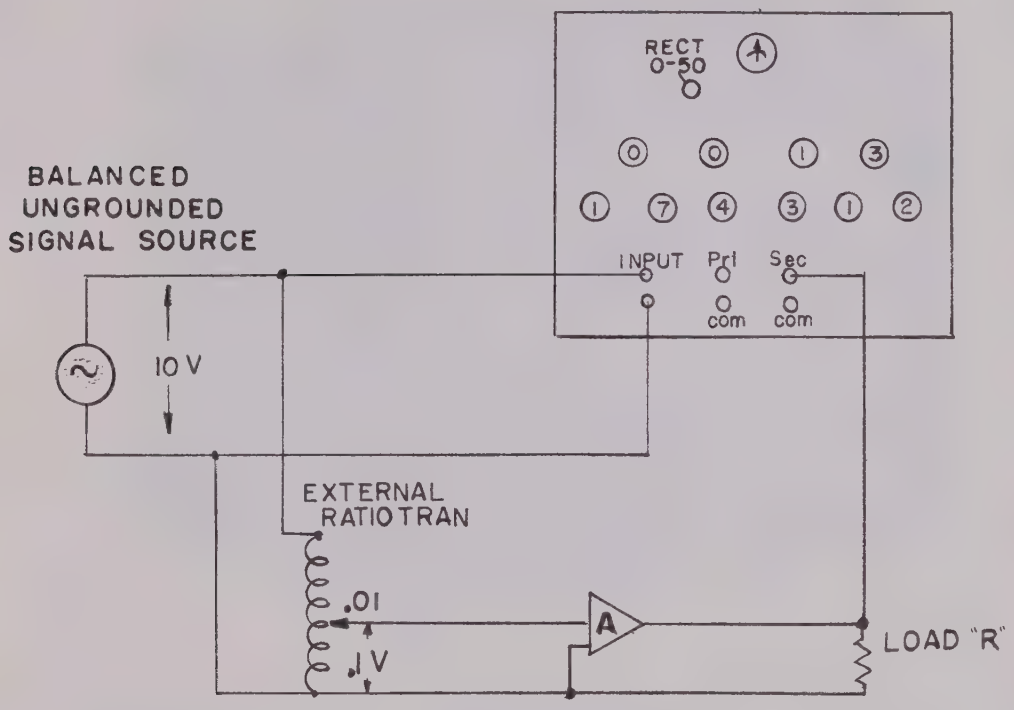
Switch #1:	Pole --- Pin D
	N. C. --- Pin E
Switch #2:	Pole --- Pin F
	N. O. --- Pin J & H

NOTE: The D to E jumper must be removed, and the J to H jumper must be left in place.

WARNING: EXCESSIVE USE OF THE "Reset to 0°" FUNCTION WILL CAUSE ABNORMAL WEAR TO SOME OF THE INTERNAL COMPONENTS!

5/25/62

PRECISION AMPLIFIER GAIN AND PHASE MEASUREMENTS
(using RatioTrans or CRB Complex Ratio Bridges)



I. TEST EQUIPMENT REQUIRED

A. ONE (1) Gertsch Complex Ratio Bridge CRB-1B or CRB-2B.
B. ONE (1) RatioTran, Gertsch Model RT-5 or equivalent.
C. Signal Source.

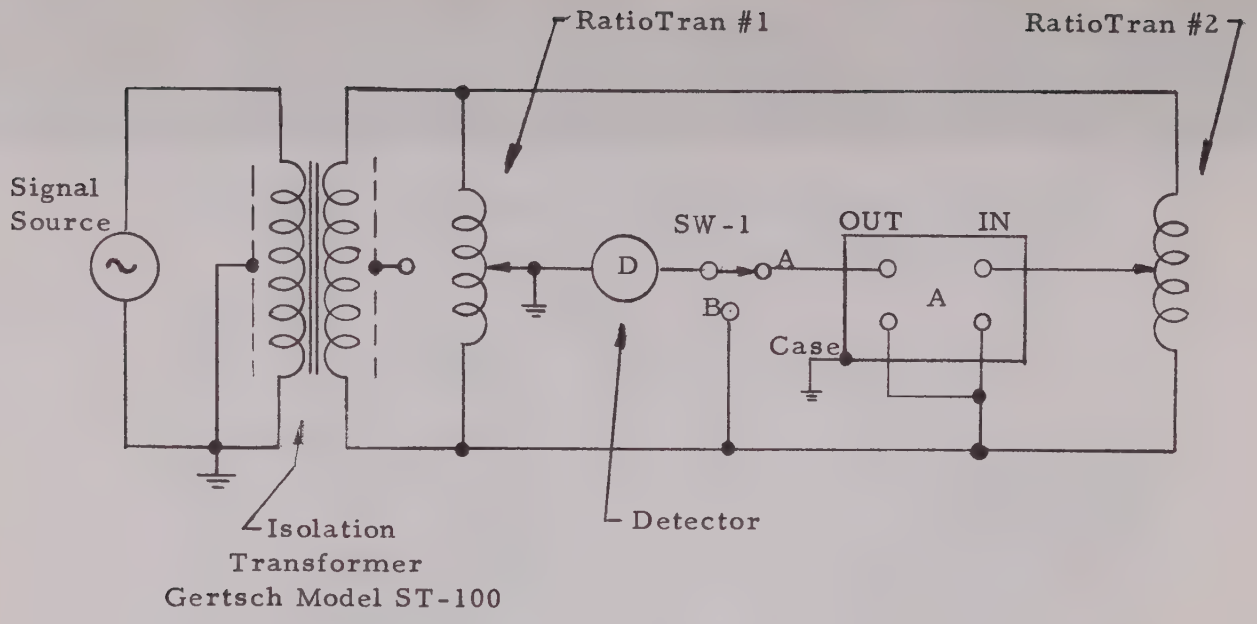
II. PROCEDURE

A. Connect test equipment and amplifier as shown.
B. Adjust CRB for proper in-phase and quadrature null.
C. At null, reading on CRB dials should be divided by ratio of external RT.

Example: External RT set to .01 ratio. At null, in-phase RT in CRB reads .174312. Amp. Gain = $\frac{.174312}{.01}$ = 17.4312

III. QUADRATURE

A. For quadrature, readings on Rect. position should be divided by the external RT ratio. Tangent and Degree positions read directly.



I. TEST EQUIPMENT REQUIRED

A. ONE (1) Isolation Transformer, Gertsch Model ST-100 or equivalent.
B. TWO (2) RatioTrans, Gertsch Model RT-5 or equivalent.
C. ONE (1) High Impedance Detector, VTVM or Scope.
D. Signal Source.

II. PROCEDURE

A. Connect the test equipment and amplifier as shown above. NOTE: If the amplifier ground and case are common, DO NOT connect to bridge ground. The bridge is grounded at one point only as shown.
B. Adjust RatioTran #2 for the proper amplifier input level.
C. Adjust RatioTran #1 for minimum output on detector.
D. Voltage gain of amplifier is ratio of RatioTran readings.

III. PHASE SHIFT MEASUREMENT

A. To measure phase shift, the output level on the detector is noted (the voltmeter reading if a VTVM is used, or the pattern height if a scope is used).
B. Switch SW-1 is moved to a position B and RatioTran #1 adjusted for same detector level as noted in III-A above.
C. The quadrature component of the amplifier output is now indicated on RatioTran #1. The amplifier phase shift is derived from the relationship:

$$\text{Tan } \Theta = \frac{\text{RatioTran \#1 (III-C)}}{\text{RatioTran \#1 (II-C)}}$$

where Θ = phase angle

Gertsch

E.H. LONGBRAKE

MODEL CRB-3

Automatic Complex Ratio Bridge

MODEL CRB-3

MODEL CRB-3

FEATURES

- Self-nulling
- Extremely high accuracy { in-phase ratios greater than .005% of range; quadrature ratios greater than .05% of range + calibration
- Automatic quadrant selection and indication
- 3, 4, or 5 place resolution
- Measures step-up ratios as high as 1:6
- Self-contained (requires no external calibration sources)
- Parallel printer output
- Fast nulling (average, 10 seconds)

• DETAILED SPECIFICATIONS ON INSIDE

E.H. LONGBRAKE

Gertsch

GERTSCH PRODUCTS, Inc.
3211 South La Cienega Boulevard, Los Angeles 16, California • UPton 0-2761 — VErmont 9-2201

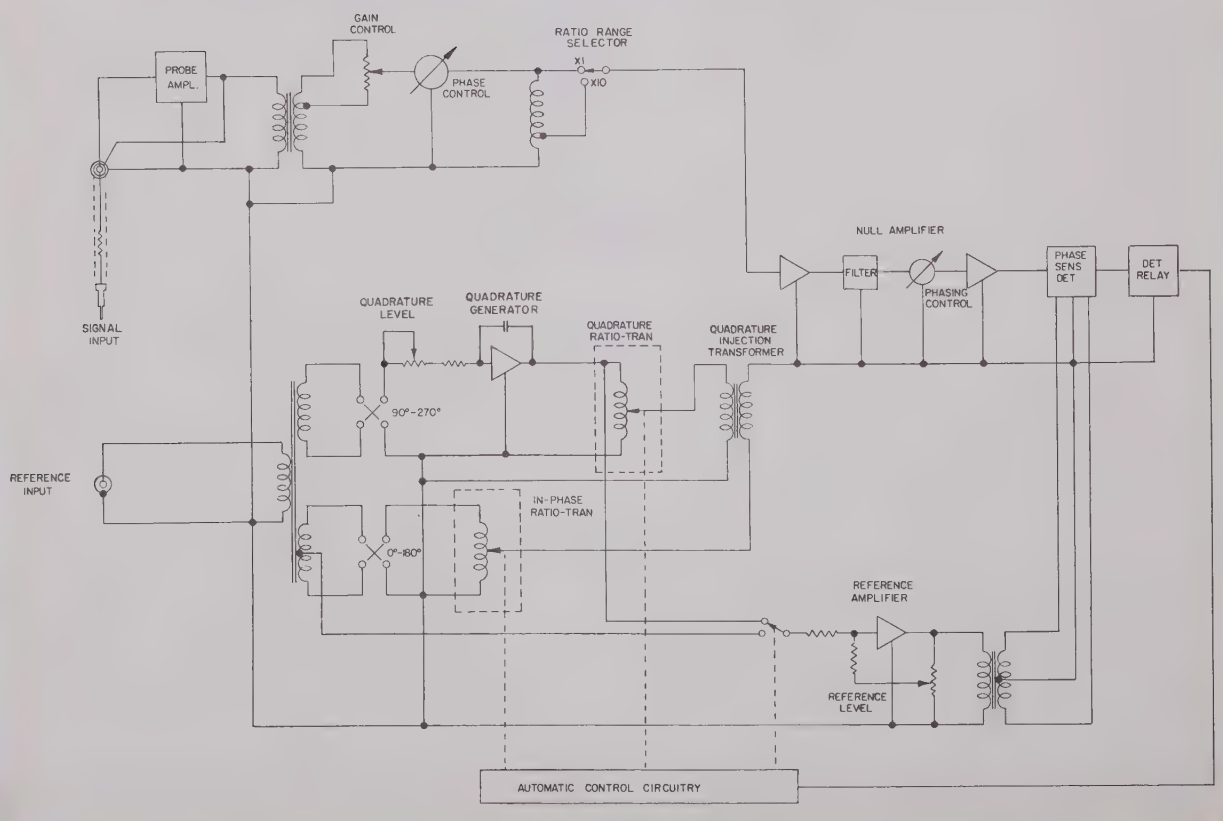
GENERAL DESCRIPTION

Gertsch Model CRB-3 Automatic Complex Ratio Bridge is a self-nulling AC bridge. Unit displays both in-phase and quadrature ratios on a 5-place Nixie readout. It permits fast, accurate measurements without the need for a skilled operator.

This bridge is basically a solid state design using only 2 vacuum tubes. Instrument provides many savings in both time and money for manufacturers and users of transformers, synchros, resolvers, tachometers, all types of transducers, AC amplifiers, attenuators, AC networks, analog computers and other AC systems where performance can be evaluated through voltage ratio analysis.

Unit takes advantage of the accuracy and versatility of bridging techniques by measuring ratios, rather than absolute voltage magnitudes. Isolation of the unit under test is accomplished by a unity gain probe amplifier, which produces a minimum input impedance of 10,000 megohms. This feature virtually eliminates loading errors and grounding problems.

CRB-3 BLOCK DIAGRAM



CIRCUITRY DESCRIPTION

The basic circuit is illustrated in the block diagram at the left. Output of the unit under test is applied to the probe input, and amplified through the probe amplifier. This is a unity gain amplifier with extremely high feedback, which produces exceptional linearity and stability. Another feature of this amplifier is the extremely high input impedance of approximately 10,000 megohms, which virtually eliminates any loading errors on the device under test. When the probe is connected to the reference input (unity), amplifier gain is calibrated to exact unity by means of the gain control. Any phase shift occurring at this time is corrected by the probe amplifier phase control.

Output of the probe amplifier feeds into the input of a transistorized null amplifier, which is floating with respect to ground. The sum of the in-phase and quadrature RatioTrans drives the common of the null amplifier through the quadrature injection transformer. The amplifier both increases and limits "off null" voltage, and feeds it into the phase-sensitive detector.

Since null can be obscured by the presence of harmonic voltages generated by the unit under test, a band-pass filter is employed to reject harmonics and noise.

Quadrature voltage applied to the quadrature RatioTran is generated by an integrating amplifier. A high ratio of open-loop-to-closed-loop gain in this amplifier produces an accurate integral of input voltage ($\sin \theta$) to appear at its output ($\cos \theta$).

A stepping switch operates each decade in both RatioTrans, and an alternating relay programs the automatic nulling sequence — locating the first decade in-phase ratio, and then the first decade quadrature ratio. This alternating selection is programmed through all decades in proper sequence. A resolution control selects 3, 4, or 5 decades of resolution, as desired.

For locating correct ratios, the phase-sensitive detector utilizes both in-phase and quadrature references. A sensitive polarized relay in the detector output is so wired that its contacts are open when the ratio is less than the ratio being measured (under null), and closed when the ratio is greater (over null).

The detector relay drives another relay which controls the clock pulses to the decade stepping switches. When the stepping switch in the active decade advances one digit beyond null, the detector relay closes to drive this relay; and an alternating relay transfers the drive pulses to the other RatioTran (quadrature or in-phase). Simultaneously, the previously nulled RatioTran decade drops back one digit (below null). This process repeats until all selected decades have been operated. Upon completion of the nulling operation, drive pulses terminate, the "read" light is actuated, and another relay (connected to the auxiliary printer output) is actuated. Ratio is now read directly from the Nixie readout in the form of $\pm$Rx, $\pm$jRy.

To prepare for another measurement, the "operate/clear" switch is actuated, and all RatioTrans clear (return to zero). A second actuation of the "operate/clear" switch begins another automatic nulling operation.

CRB-3 starts operation in the first quadrant (0°-90°). If the detector relay is actuated before the decade stepping switch starts, phase of the operating channel (either in-phase or quadrature) is reversed automatically. Phase is indicated on the Nixie readout as a "plus" for 0° or 90°, and a "minus" for 180° or 270°.

Since output of the probe amplifier can be adjusted to divide by 10, CRB-3 could measure ratios as high as 10:1. However, with the restrictions of a 20V minimum reference input, and a 125V maximum probe input, the maximum measurable ratio is 125/20, or 6.25:1.

Gertsch PRODUCTS, INC.

SPECIFICATIONS

Readout	5-place Nixie, plus quadrant indication for both in-phase and quadrature ratios.
Auxiliary Output	Parallel 10 line, for printer.
Average nulling time	Less than 10 seconds.
Operating Frequency	400 cps ±5% (other frequencies available on request)
Max. Signal Input Voltage	125 volts
Max. Reference Input Voltage	125 volts
Min. Reference Input Voltage	20 volts
Signal Input Impedance	Greater than 10,000 megohms
Reference Input Impedance	Greater than 50,000 ohms
Input Power	200 watts at 115/230V, 50-60 cps
Ratio Ranges	.00000 to .99999 0.0000 to 6.0000 Controlled by front-panel selector switch.
Size	Cabinet: 19½" W x 16½" H x 16" Deep Rack: (4 panels) each, 19" W x 3½" H x 13" Deep
Weight	100 lbs., approx.

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FOR FURTHER INFORMATION REGARDING THIS AND OTHER GERTSCH PRODUCTS, CONTACT THE FACTORY OR YOUR NEAREST GERTSCH REPRESENTATIVE

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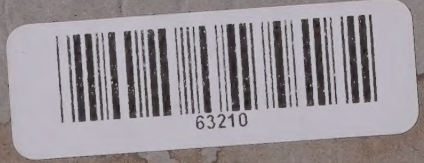
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